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A gesture-controlled Serious Game for teaching emotion recognition skills to preschoolers with autism

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ABSTRACT
The recognition of facial expressions is important for the perception of emotions. Understanding emotions is essential in human communication and social interaction. Children with autism have been reported to exhibit deficits in the recognition of affective expressions. With the appropriate intervention, elimination of those deficits can be achieved. Interventions are proposed to start as early as possible. Computer-based programs have been widely used with success to teach people with autism to recognize emotions. However, those computer interventions require considerable skills for interaction. Such abilities are beyond very young children with autism as they have major restriction in their ability to interact with computers. Our approach takes account of the specific characteristics of preschoolers with autism and their physical inabilities. By creating an educational computer game which provides physical interaction, we aim to support early intervention and to foster emotion learning.

Keywords
Serious Games, Gesture-based interaction, Natural User Interface, Autism, Facial emotion recognition

1. INTRODUCTION
Social interaction impairments, a core feature of ASD, involve difficulties in understanding and expressing emotions [1]. Children with autism often fail to recognize the qualitative differences and associations between the various expressions of emotions. Those deficits seem to be rather permanent in individuals with autism so intervention tools for improving those impairments are desirable. Also, as the number of children diagnosed with autism increased [2], new methods for educating this population become necessary.

It is claimed that Computer Assistive Technologies (CAT) and in particular serious games [3] can be very effective [4] in the areas of therapy and education for children with autism. Furthermore, educational interventions for teaching emotion recognition from facial expressions should occur as early as possible in order to be successful and to have a positive effect [5]. However, those computer interventions require considerable skills and in particular the ability to control the mouse or to use the keyboard. Before the age of 6, most children with autism experience motor control problems in their hands and demonstrate delays in fine motor skills which cause difficulties in grasping and manipulating objects, such as a mouse [6].

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2. DESIGN AND IMPLEMENTATION
In this paper we present an educational computer-based single player game specially designed for Greek preschoolers with autism. Our aim is to teach them facial emotion recognition so as to enhance their social interaction.

The development of our game was based on the following main principles. As a serious game, it should have an impact on the player in a real life context [7]. A recent study conducted to analyze user needs for serious games for teaching children with ASD emotions, revealed the characteristics of the children's game play behaviors [8]. The observation showed repetition, matching instead of learning the features, lack of holistic face processing and deliberately incorrect selection. On account of those findings, our game was intentionally designed to avoid those behaviors. Additionally, our design incorporates a theory-driven game design framework supported by learning and developmental theories. The framework is based on the integration of the experiential learning model and the cognitive model [9]. From the above systematic approach, six essential elements (matching, recognition, observation, understanding, generalizing and mimicking) were extracted for designing games to teach children with ASD emotions. These elements were taken into consideration during the design process of our serious game.

2.1 Game Environment
The game environment is simple and less detailed in order to avoid children's distraction. Individuals with autism are reported to have enhanced perception of details [10] which may cause distraction. For these reasons we have chosen black context presented on a white background and grayscale stimuli. Game begins with an instruction page where the child is informed what is going to happen, what he/she has to do and how he/she can do it. When the child feels ready, he/she can choose to start the game. The game provides a structure learning environment which consists of 3 different levels with increasing difficulty. Breaking the teaching intervention into small learning steps makes the task easier to perform. In the first level children should learn labeling emotions, in the second level they should learn to recognize emotions from facial features and in the third level they should learn to identify the causes of various feelings in different situations, obtained through the use of social stories.

Individuals with autism are usually visual learners, which mean that they understand written words, photos and visual information better than spoken language. For teaching emotions, it is recommended to describe each feeling pictorially by using pictures with clear outline, minimal details and color [11]. For young children it is advisable to keep to the basic emotions (happy, sad, angry, scared and surprised). The face stimuli we used are 15 grayscale photographs of male and female faces, taken from the CAlifornia Facial Expressions (CAFE) dataset [12]. All images used in the game, meet FACS criteria [13] and all faces have been certified as "FACS-correct". The stimuli are presented on each trial with different pair of photos and the goal is to choose the correct image among the two.

2.2 System Development

Our game is implemented with the use of Kinect, which is a motion sensing input device by Microsoft for Windows PCs. Kinect is a cheap and simple device for motion capturing. It offers simple and reliable skeleton tracking as well as an open source SDK. By using Visual studios 2010 we were able to use the Kinect SDK 1.6 released by Microsoft with C# as backend. The advantages of using C# were a) capability to integrate XNA Game Studio 4.0 to develop our game using Kinect and b) possible to utilize the XNA libraries (provided by Microsoft) to create the graphics.

2.3 Interaction with the System

Interaction may be one of the areas that need to be developed with extreme care. Our gesture-based interaction approach moves the control of computer from a mouse and keyboard, to the motions of the body via new input devices. Our game is designed to use non-touch based NUI and to be controlled by hand gestures. The player has three possible actions in all game states, to choose the left or the right image and to move to the next play area. These basic actions are implemented with efficient and easy to use gestures. Moving to the next play area requires a two-hand gesture which is performed by moving both hands above the head. Selecting the left or the right image (the orientation of the image is decided by looking toward the screen) requires one-hand gesture which is performed by moving the left or the right hand above the head. During the game, if the player selects the correct or incorrect stimuli, the system will provide an audio and a visual feedback such as operation-related sounds and changing the images' color. A voice telling "Bravo" rewards player for the correct answer and for the incorrect answer a voice telling "Try again" encourages the user to retry. There are no other sound effects because individuals with ASD may suffer from auditory sensitivity and may feel discomfort when exposed to certain sounds [14]. Visual feedback is also provided by changing the image's color into light green for the correct answer and into light red for incorrect answer. Light colors were selected because in ASD occur a reduced chromatic discrimination that is due to general reduction in sensitivity [15].

3. DISCUSION AND FUTURE WORK

Serious games with NUI interaction are a promising intervention strategy because they are appealing and motivating for young children to use as well as convenient to access. When the control is done through natural gestures, the user does not have to learn how to perform the action and how to operate the game.

Future work could include the design of special gestures aiming to improve children fine motor skills or the design of a serious game that will enable children to make facial emotion expressions that the system will be able to detect in order to support the "learn by doing" method.

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